

IAS Delta System/Preliminary Design Review

Agenda

- Introduction J. Henegar
- System Architecture Overview T. Ulrich
- Operations Concept R. Whitman
- IAS Software Subsystem Design
 - Process Control Subsystem J. Garrahan
 - Data Management Subsystem J. Garrahan
 - Evaluation and Analysis Subsystem D. Kaufmann
 - Radiometric Processing Subsystem J. Rowe
 - Geometric Processing Subsystem J. Storey
 - End-to-End Scenarios J. Garrahan
- IAS Hardware Architecture D. Slater
- Wrap-up

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Subsystem Design Topics

- Purpose**
- Driver Requirements**
- Process Model**
- Task Design**

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	Data Management System (DMS) Purpose	

- **Ingest level 0R product from EDC DAAC**
- **Validate and correct level 0R product**
- **Ingest ephemeris and reports from the MOC**
- **Generate Calibration Parameter File (CPF)**
- **Distribute products (CPF, reports) to external facilities**
- **Monitor Disk Usage**

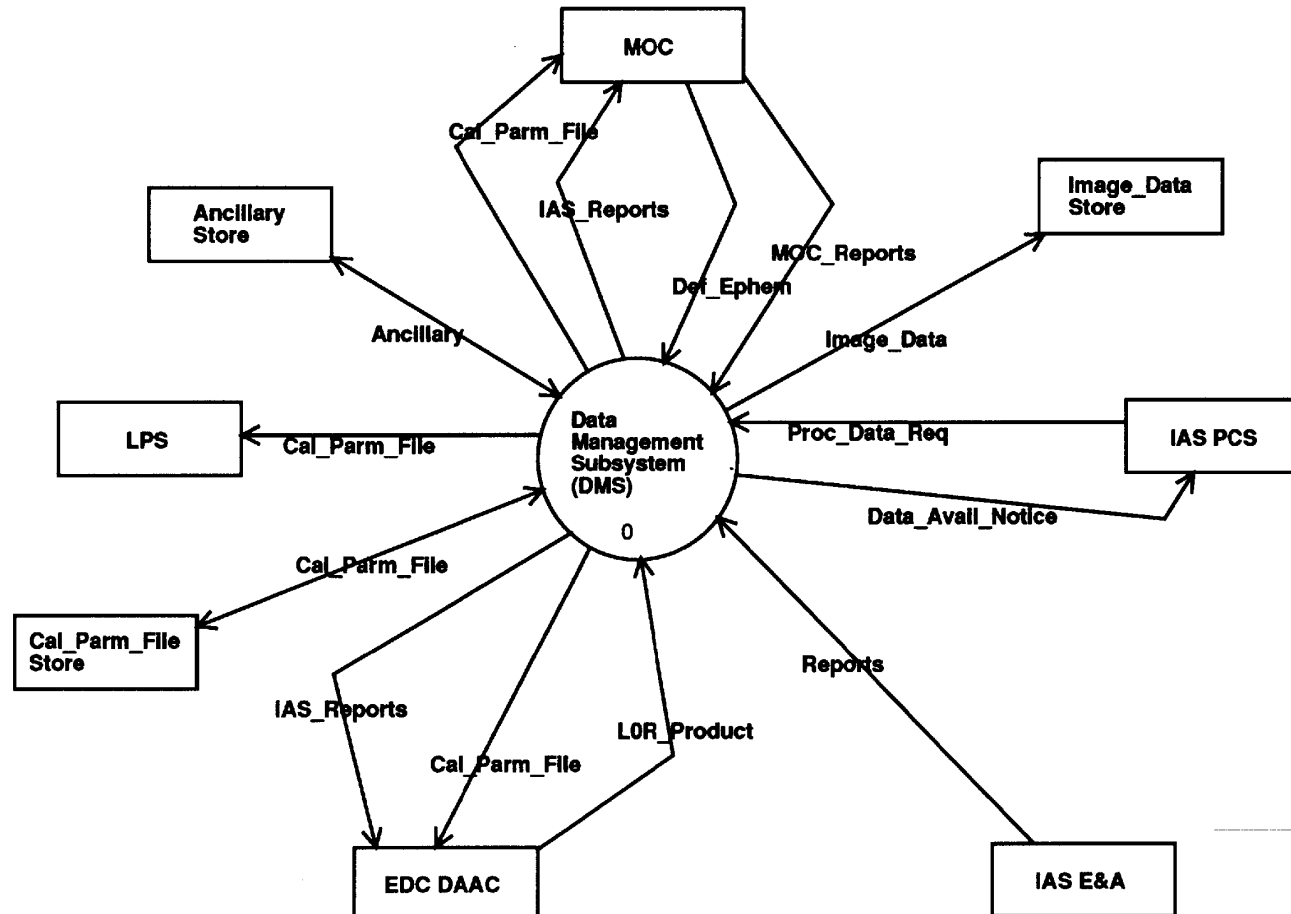
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DMS Key Requirements

Reqt Number	Requirement Statement
3.2.1.1.2	The IAS shall receive Level 0R data, Level 0R products, and associated ancillary data from the EDC DAAC.
3.2.1.1.4	The IAS shall send calibration parameter files and IAS-generated reports to the EDC DAAC.
3.2.1.2.4	The IAS shall send calibration parameter files to the LPS.
3.2.1.3.1	The IAS shall send requests to the MOC for the operational acquisition of partial-aperture calibration data, full-aperture calibration data, and surface image data of radiometric and geometric calibration ground sites.
3.2.1.3.3	The IAS shall send requests to the MOC for concentrated definitive ephemeris.
3.2.1.3.5	The IAS shall send calibration parameter files to the MOC.
3.2.1.3.7	The IAS shall be capable of receiving Flight Dynamics Facility (FDF)-generated, definitive ephemeris from the MOC.
3.2.2.3.1	The IAS shall be capable of processing payload correction data (PCD) data to correct spacecraft time, generate a sensor pointing model (attitude and jitter), and calculate spacecraft position and velocity (ephemeris).
3.2.2.4.12	The IAS shall be able to evaluate the quality of Level 0R products. Quality checks will include but not be limited to those listed in Table 3.2.2.4-1.
3.2.3.18	The IAS shall provide regular calibration and performance updates to the EDC DAAC and other interfaces quarterly.

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DMS Context Diagram



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	DMS Process Model	

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	Process Control Subsystem (PCS) Purpose	

- **Schedule work order for processing**
- **Monitor progress of work order**
- **Notify analyst for intermediate action on halted work order**
- **Notify analyst for assesment of completed work order**

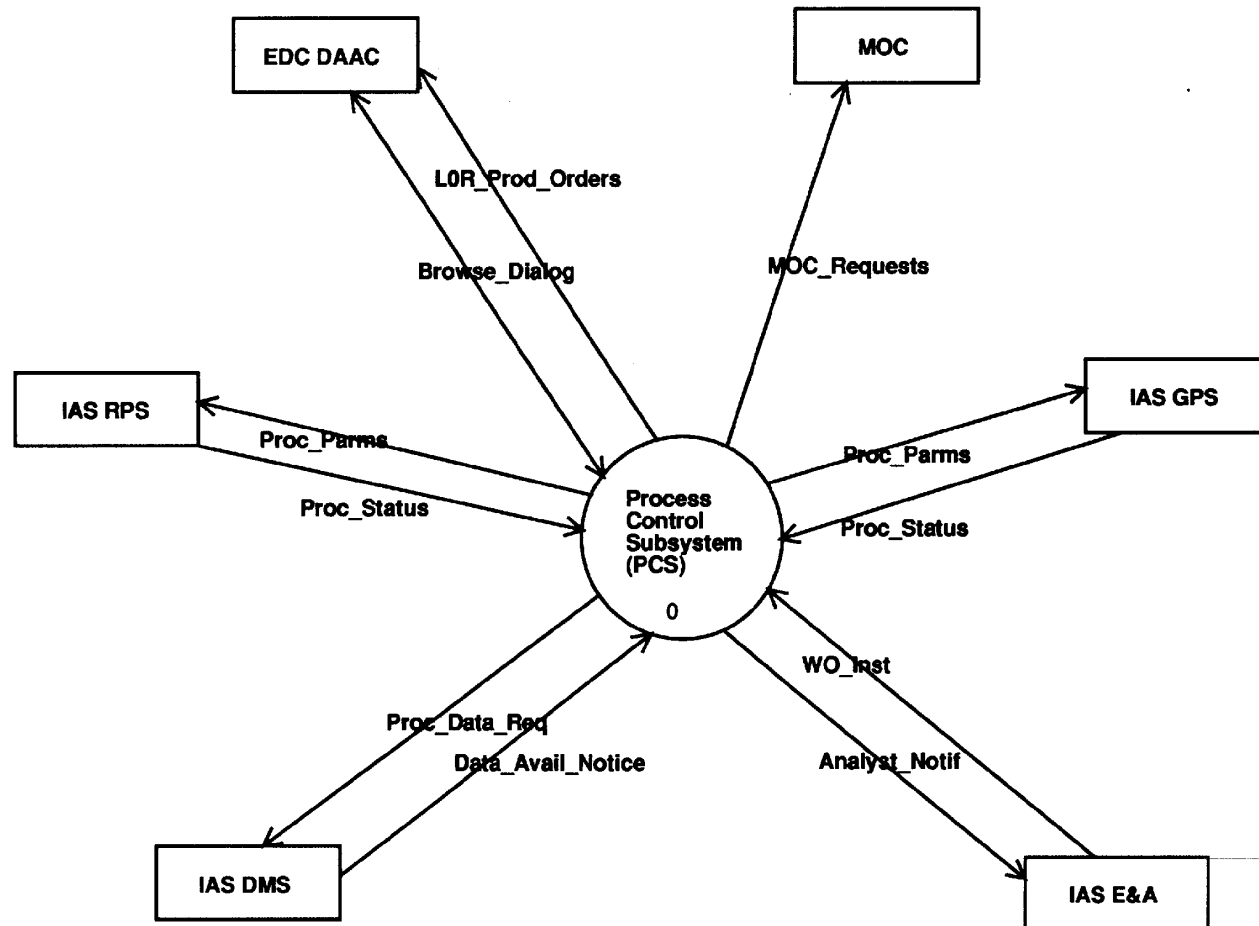
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PCS Key Requirements

Reqt Number	Requirement Statement
3.2.1.3.1	The IAS shall send requests to the MOC for the operational acquisition of partial-aperture calibration data, full-aperture calibration data, and surface image data of radiometric and geometric calibration ground sites.
3.2.1.3.3	The IAS shall send requests to the MOC for concentrated definitive ephemeris.
3.2.2.6.1	The IAS shall provide the capability to select the processing to be applied to data sets.
3.2.2.6.4	The IAS shall have the ability to monitor and control processes.

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PCS Context Diagram



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PCS Process Diagram

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Global Routines

- **xxx_UserAlarm**
- **xxx_Logger**
- **xxx_GetParam**
- **xxx_PutTrend**
- **xxx_GetEphemeris**
- **xxx_BuildImageProduct**

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	Evaluation and Analysis Subsystem Purpose	
<ul style="list-style-type: none">• The purpose of the E&A Subsystem is to provide the tools required by an IAS Analyst to<ul style="list-style-type: none">– evaluate and analyze ETM+ instrument performance– perform anomaly investigations– maintain the Calibration Parameter File– generate reports detailing calibration, assessment, evaluation, and anomaly resolution activities		

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E&A Key Requirements (1 of 2)

Number	Requirement Statement
3.2.2.4.12	The IAS shall be able to evaluate the quality of Level 0R products. Quality checks will include but not be limited to those listed in Table 3.2.2.4-1.
3.2.2.4.13	The IAS shall be capable of performing a trend analysis over any desired time interval for each selected evaluation activity.
3.2.2.4.15	The IAS shall provide the capability to visually inspect image data.
3.2.2.4.16	The IAS shall provide a capability that allows an image analyst to monitor assessment processes and results.
3.2.2.4.17	The IAS shall have the capability to review output data, including but not limited to calibration reports and updates.
3.2.2.7.1	The IAS shall generate calibration, data quality assessment, and problem reports.
3.2.2.7.3	The IAS shall generate annual reports that document calibration coefficient and performance analysis trends.
3.2.3.18	The IAS shall provide regular calibration and performance updates to the EDC DAAC and other interfaces quarterly.

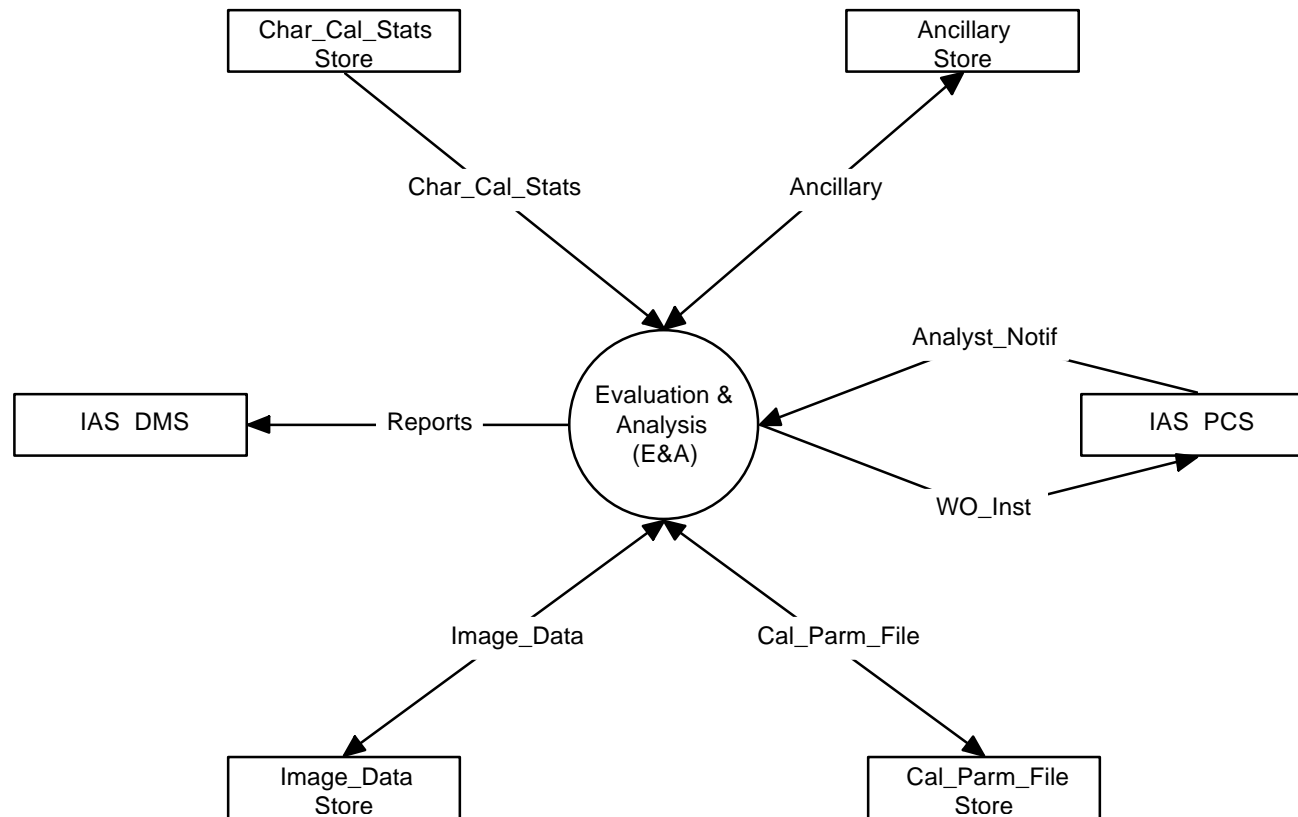
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E&A Key Requirements (2 of 2)

Number	Requirement
3.2.4.8	The IAS shall perform calibrations, assessments, and evaluations with frequencies specified in Tables 3.2.4-1 and 3.2.4-2.
3.2.4.14	The IAS capability shall be used in performing anomaly assessment, resolution, and reporting.
E&A-1	E&A shall provide capabilities (specified by E&A-1.1 through E&A-1.11) for displaying Work Order inputs, intermediate results, and outputs.
E&A-2	E&A shall provide data analysis capabilities (specified by E&A-2.1 through E&A-2.9).
E&A-3	E&A shall provide the capability to edit system input files, including image, PCD, MSCD, and Calibration Parameter files in support of “what if” analyses.
E&A-4	E&A shall provide a user interface to custom IAS applications for radiometric and geometric assessment and evaluation.
E&A-5	E&A shall provide the capability to generate reports summarizing ETM+ instrument and IAS system performance.
E&A-6	E&A shall provide the capability to insert plots and other statistical measures output by E&A data analysis applications into an analyst-generated report.

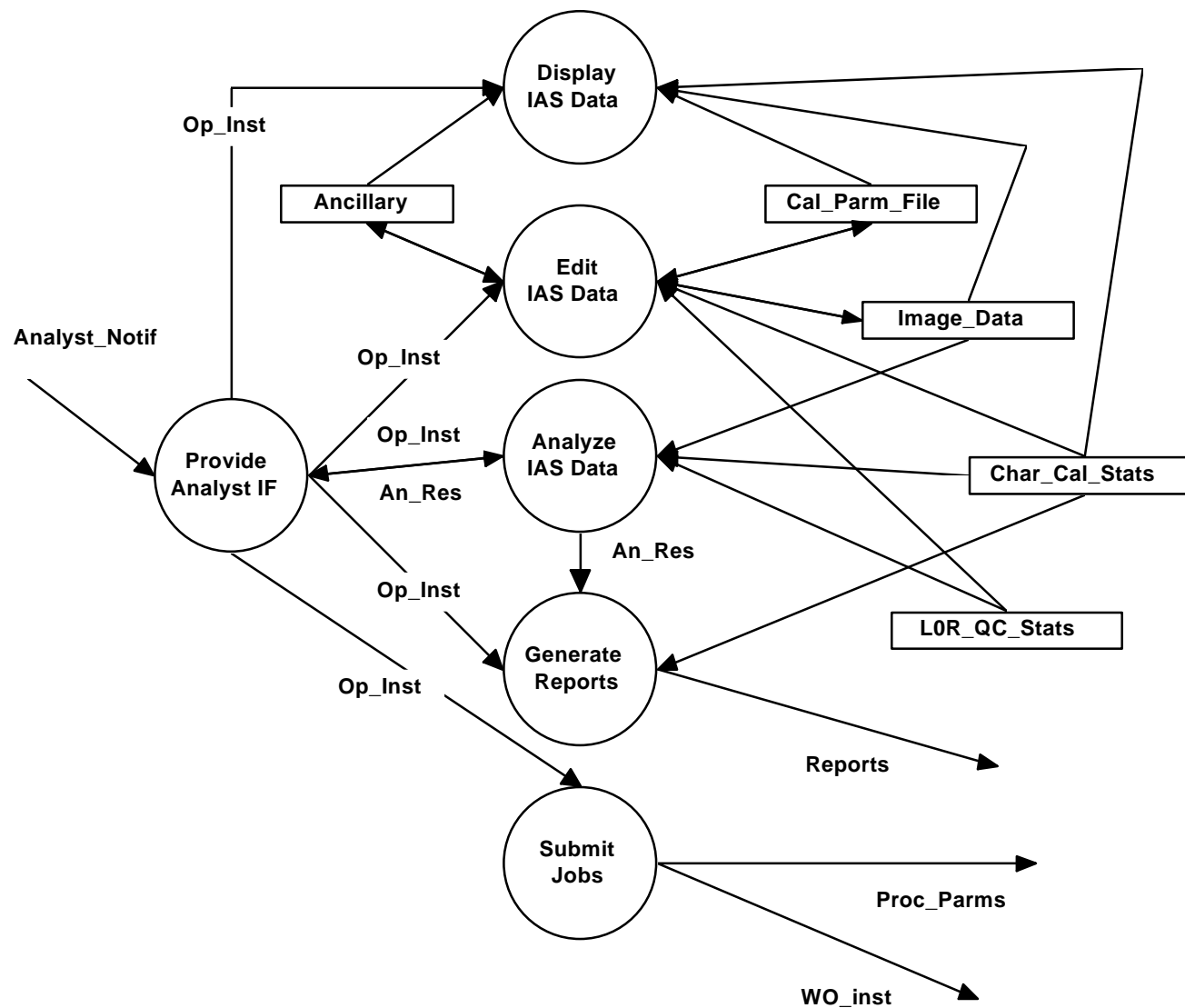
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E&A Context Diagram



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Primary E&A Functions



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	E&A COTS Products (1 of 3)	

- **IDL (Interactive Data Language)**
 - Designed for general purpose data analysis and visualization, and application development
 - Satisfies all of the E&A requirements regarding data analysis and plotting functions that are not met by ENVI
 - Provides scripting capability to produce canned routines for standard trending plots
 - Enables development of fill-in forms (with sanity checks) to be used to edit system input files for “what if” analyses
 - Text widget enables viewing of Run Log, ASCII output files, etc.

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	E&A COTS Products (2 of 3)	

- **ENVI (Environment for Visualizing Images)**
 - Designed for panchromatic, multispectral, and hyperspectral analysis of satellite and aircraft remotely sensed data
 - Provides a customizable graphical user interface for the E&A subsystem
 - Satisfies all of the E&A requirements regarding image visualization, editing, analysis, and output
 - Provides user interface to custom IAS applications for radiometric and geometric assessment and evaluation, as well as to other COTS tools
 - Implemented in IDL

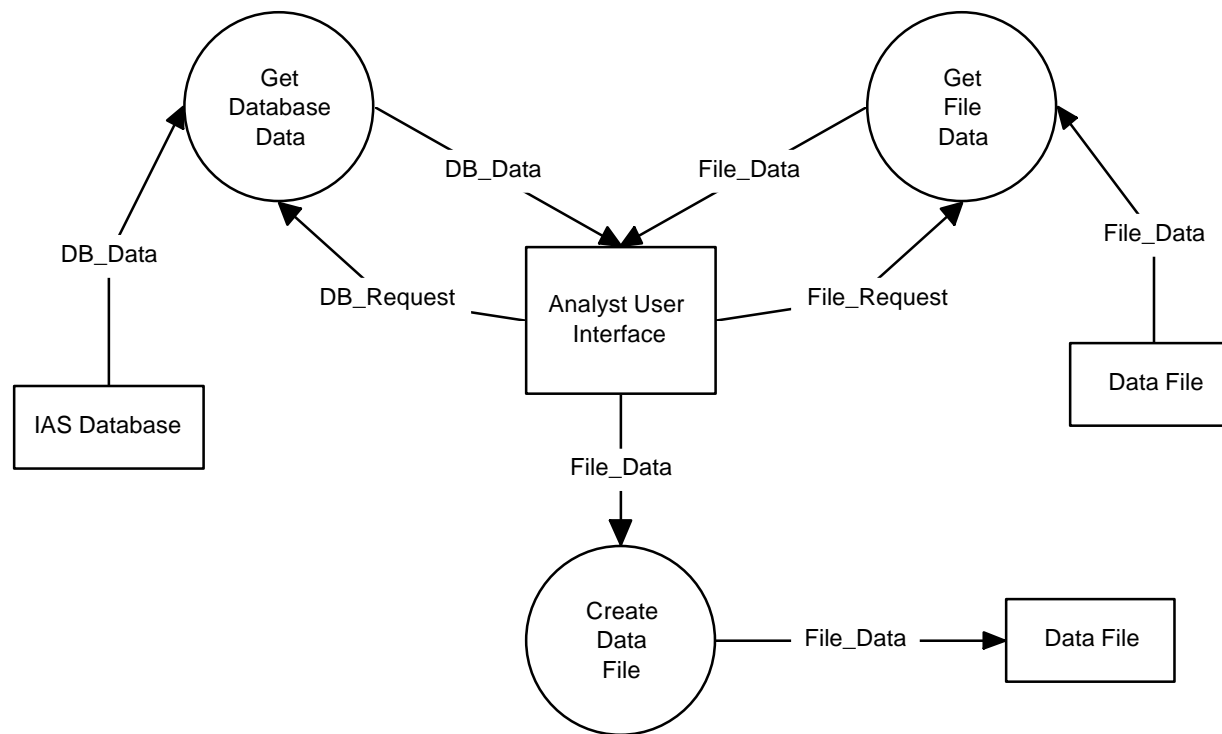
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E&A COTS Products (3 of 3)

- **FrameMaker**
 - Document publishing software that includes page layout, word processing, graphics (drawing), equations, tables, etc.
 - Used to generate reports
- **Oracle**
 - Oracle forms used by the IAS Analyst for database queries and Work Order submissions
 - Provides access to trending data for analysis

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E&A Custom Applications



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Purposes of the RPS (1 of 2)

- Perform Radiometric Calibration**
 - Uses a number of calibration sources:**
 - Internal Calibrator**
 - Partial Aperture Solar Calibrator**
 - Full Aperture Solar Calibrator**
 - Ground Looks**
 - Optimally combined the results from each calibration source (Combined Radiometric Model)**
 - Result are gains and biases to convert from digital numbers to absolute radiance**

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	Purposes of the RPS (2 of 2)	

- **Perform Level 1R Processing**
 - **Characterize data quality and artifacts in the images**
 - **Convert each pixel in a scene to absolute radiance prior to Level 1G processing**
 - **Apply calibration (gains and biases)**
 - **Correct artifacts (striping, banding, impulse noise, dropped lines, etc.)**
 - **Maintain trending databases**
 - **Short term (per orbit)**
 - **Long term (life of mission)**

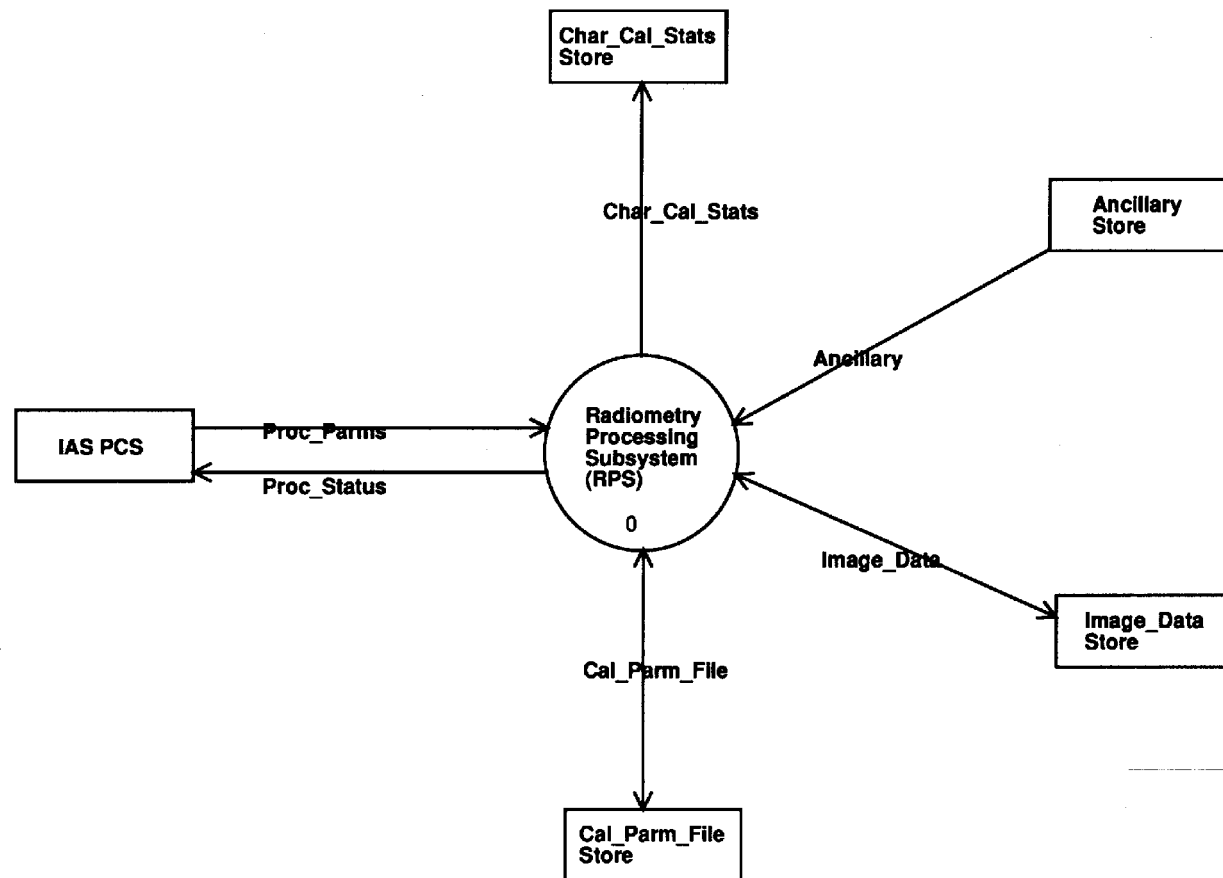
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	RPS Key Requirements	

- **Calibrate absolute radiance to 5%**
 - **Significant improvement over 10 to 20% on previous Landsats**
- **Characterize artifacts in the images**
- **Compensate for artifacts in the images**
- **Track long-term health and behavior of the ETM+**
- **Generate updates to radiometric calibration parameters**

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RPS Context Diagram

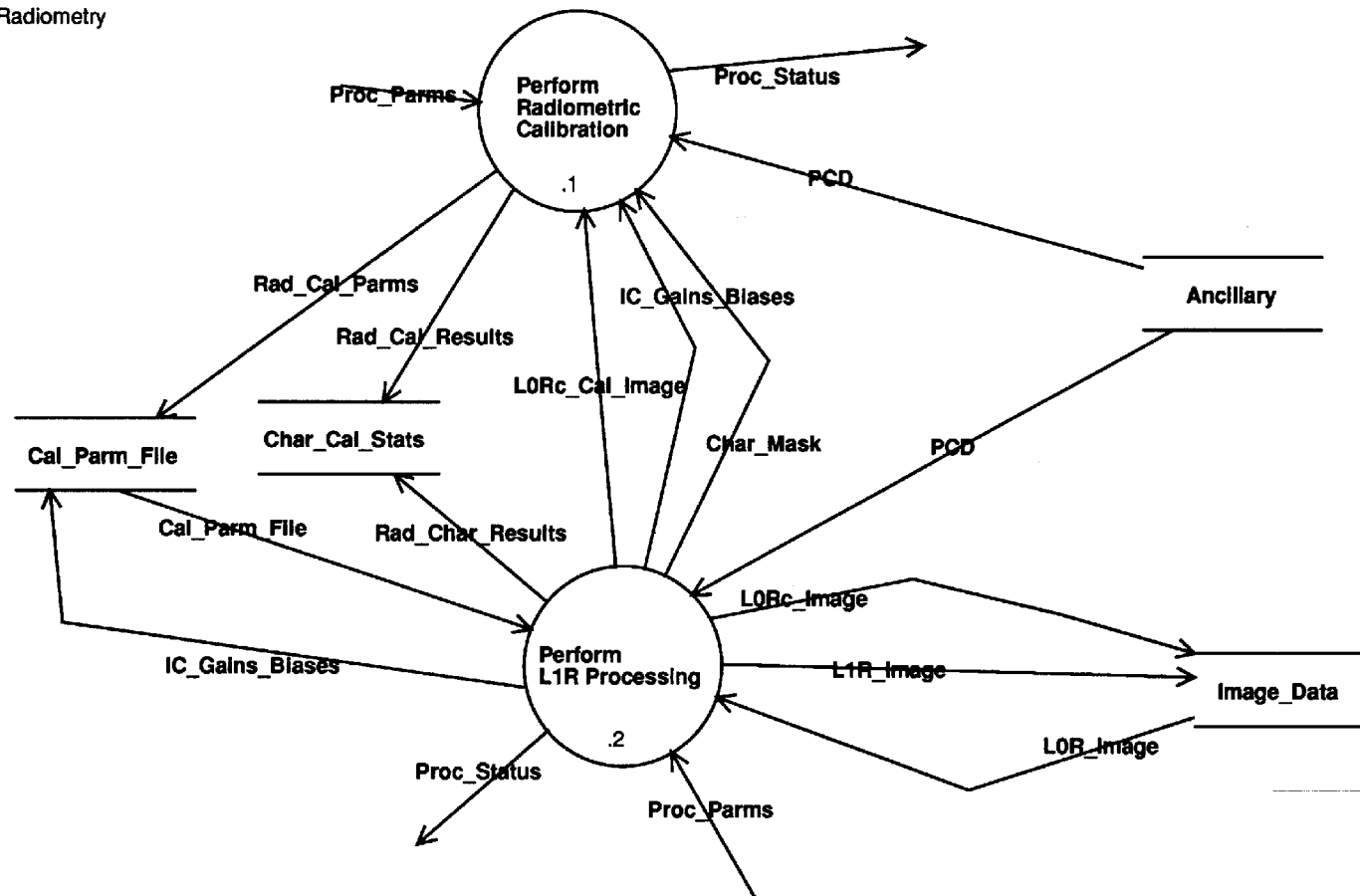
Context-Diagram;3
Landsat 7 IAS Radiometry Processing Subsystem



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RPS Level 0 Data Flow Diagram

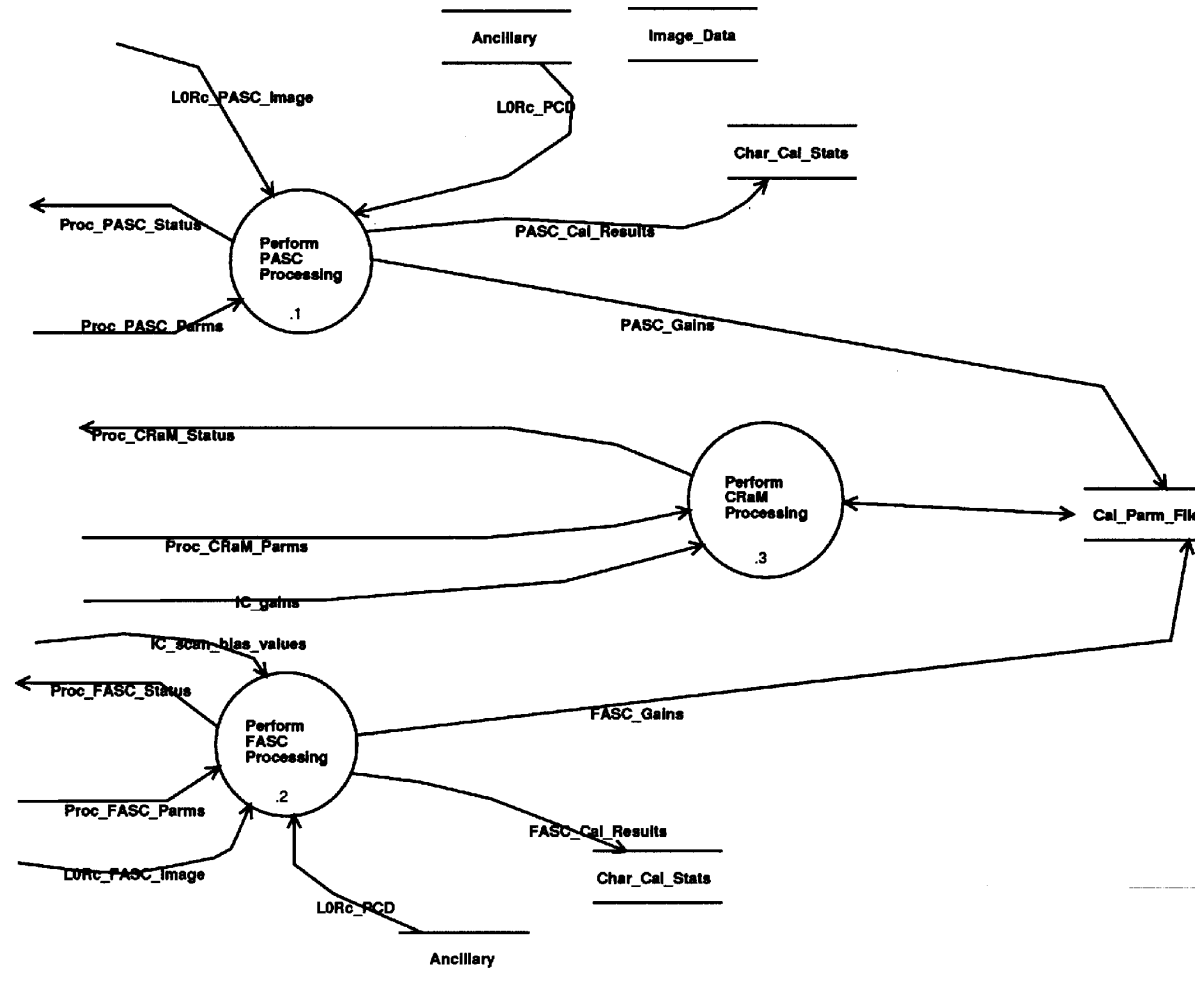
2;1
Process Radiometry



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Radiometric Calibration Data Flow Diagram

2.1.1
Radiometric Calibration

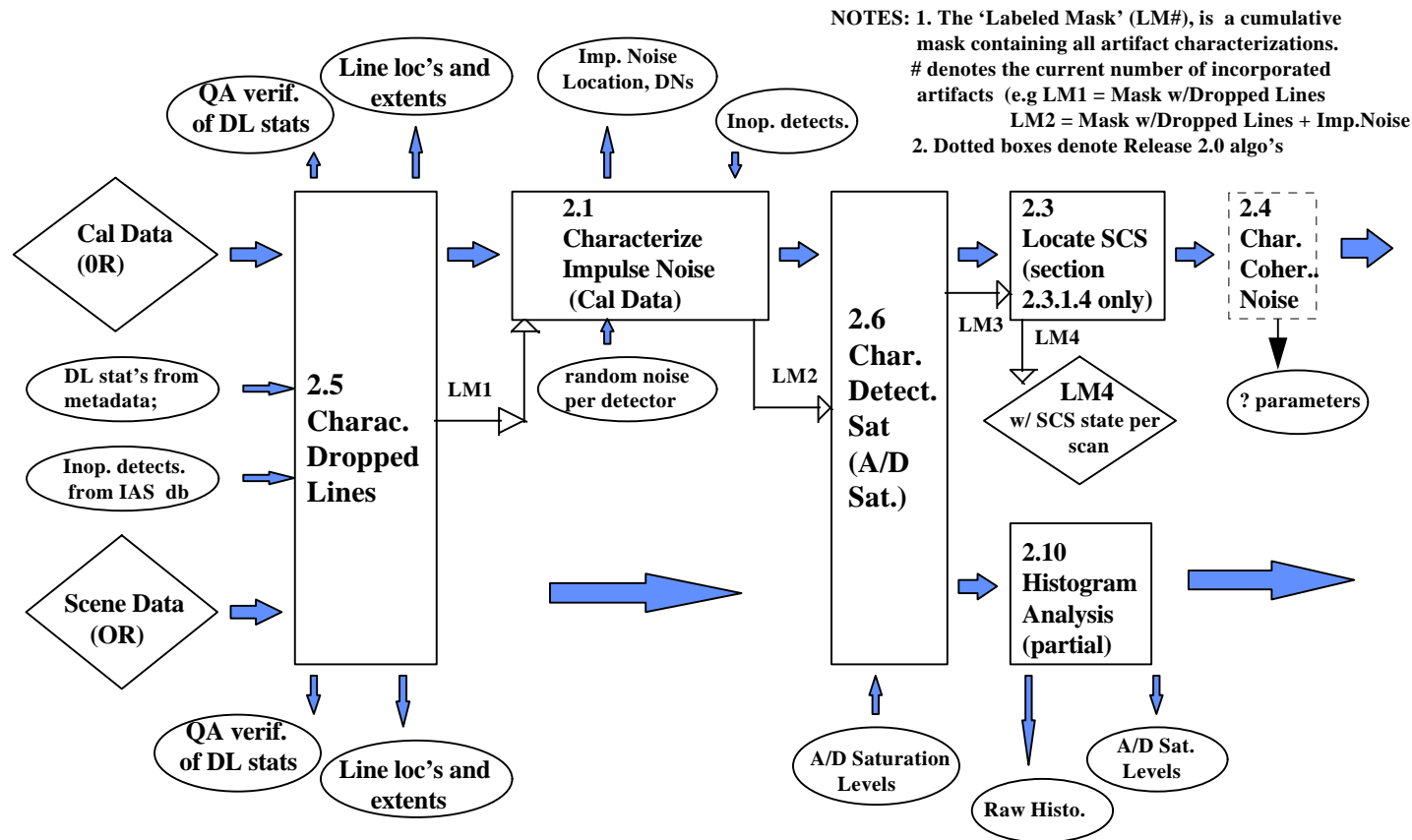


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	Level 1R Standard Processing Flow	

- **The RPS comprises approximately 40 algorithms**
- **RPS processes several different scene types, including Day, Night, PASC, FASC, and MTF**
- **For each type of scene input to IAS, there is a standard processing flow or sequence of algorithms executed as part of Level 1R processing**
- **The standard processing flows for each input scene type are presented in Appendix C of the System Design Spec**
- **The standard processing flow for a Day Scene is presented on the following pages**

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Step 1 - 0R Radiometric Characterization



Level 1R Processing (Day Scene)

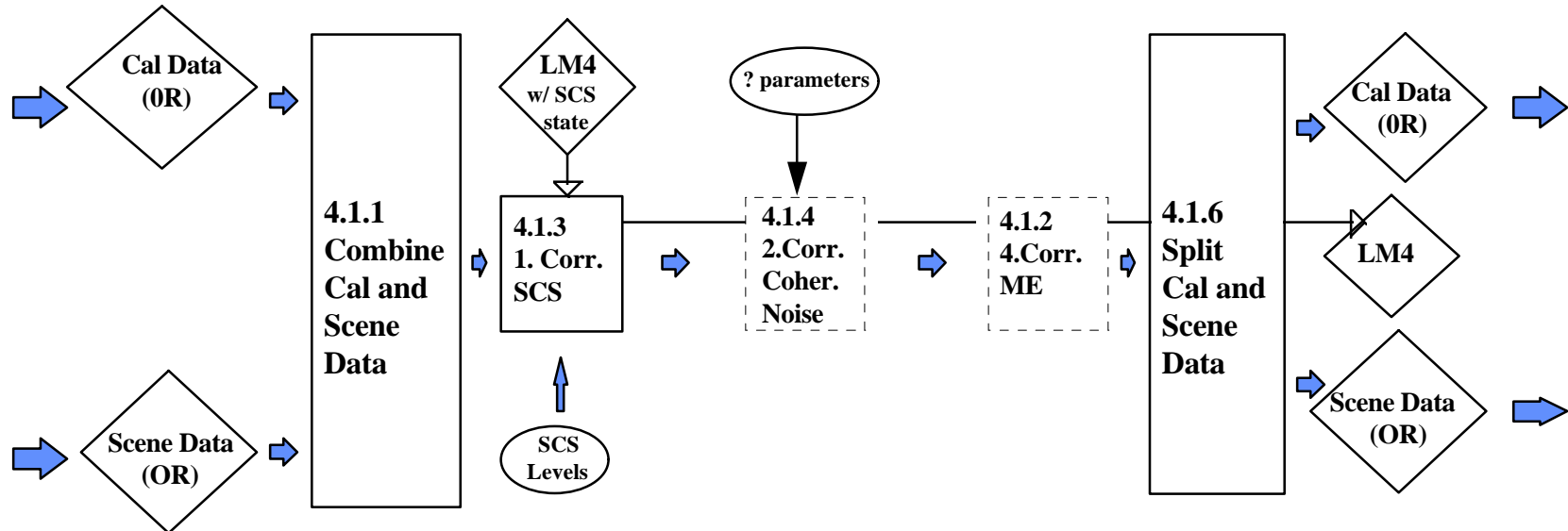
Release 1.0

Step 1. 0R Radiometric Characterization

(update 11/29/96)

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Step 2 - Pre-1R Correction



Note: Dotted boxes denote Release 2.0 algorithms

Level 1R Processing (Day Scene)

Release 1.0

Step 2. Pre-1R Correction

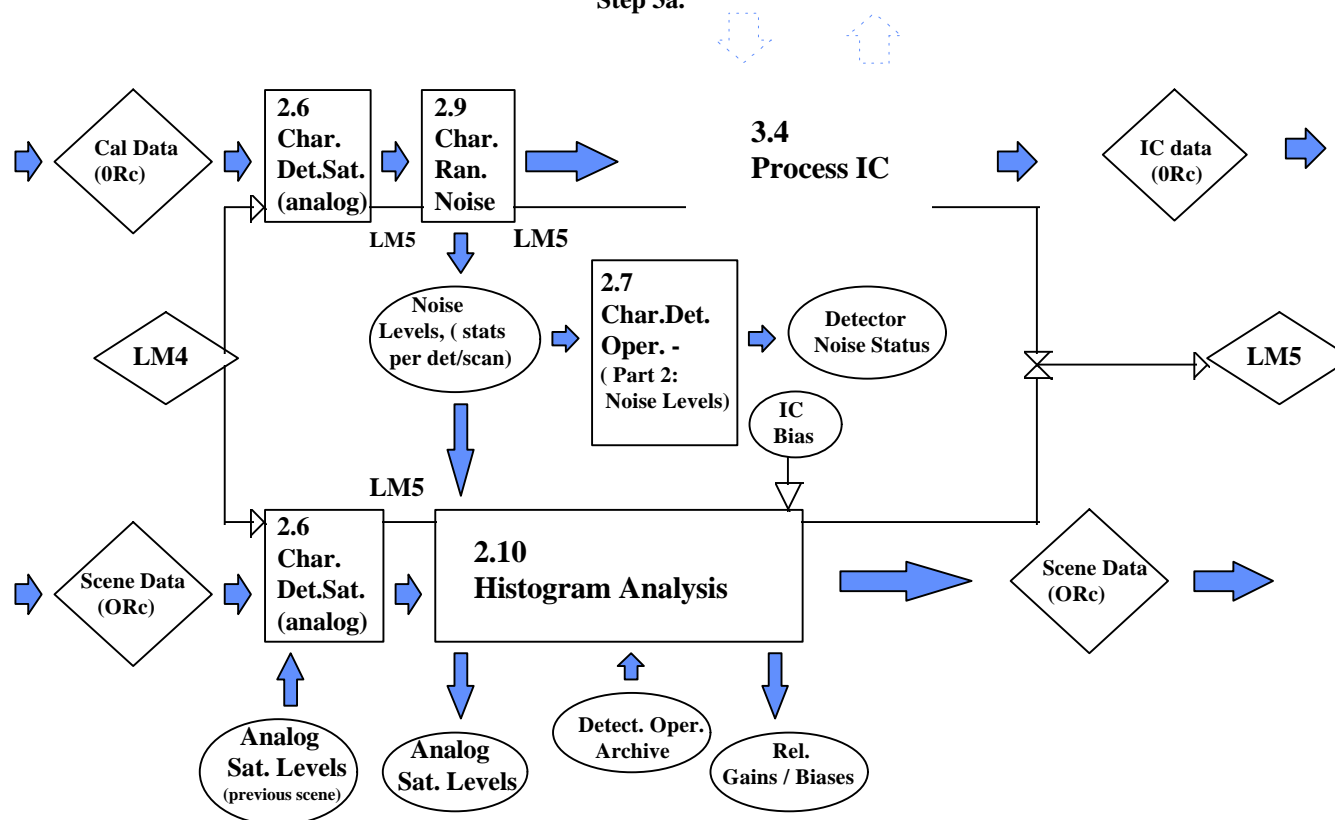
(revised 11/29/96 ssj)

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Step 3 - ORc Characterization and Calibration

Notes: 1. Dotted boxes denote Release 2.0 algo's

2. For algorithm "3.4 Process IC", see detailed flow in Step 3a.



Level 1R Processing (Day Scene)

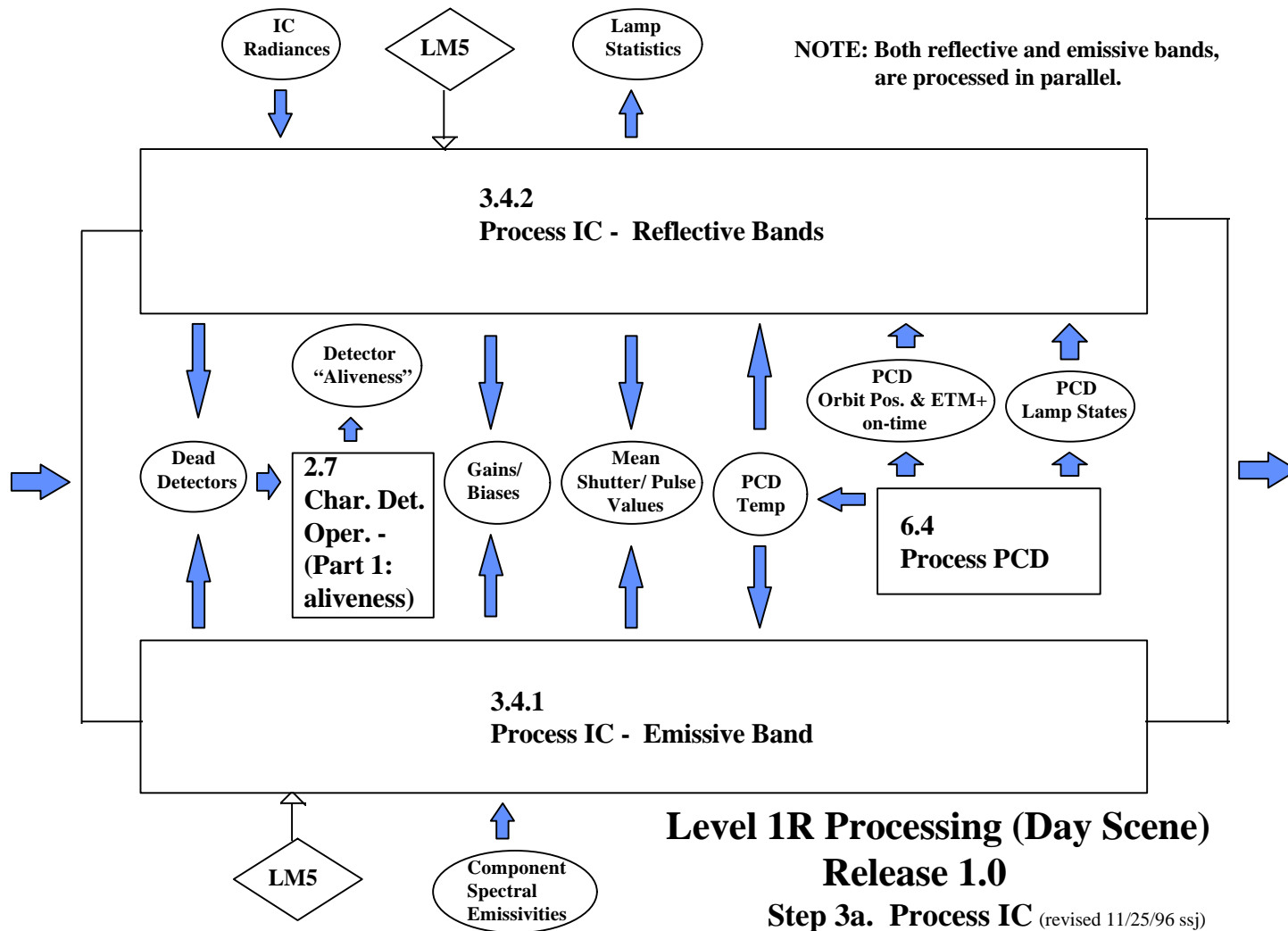
Release 1.0

Step 3. ORc Radiometric Characterization/Calibration

(revised 11/25/96 ssj)

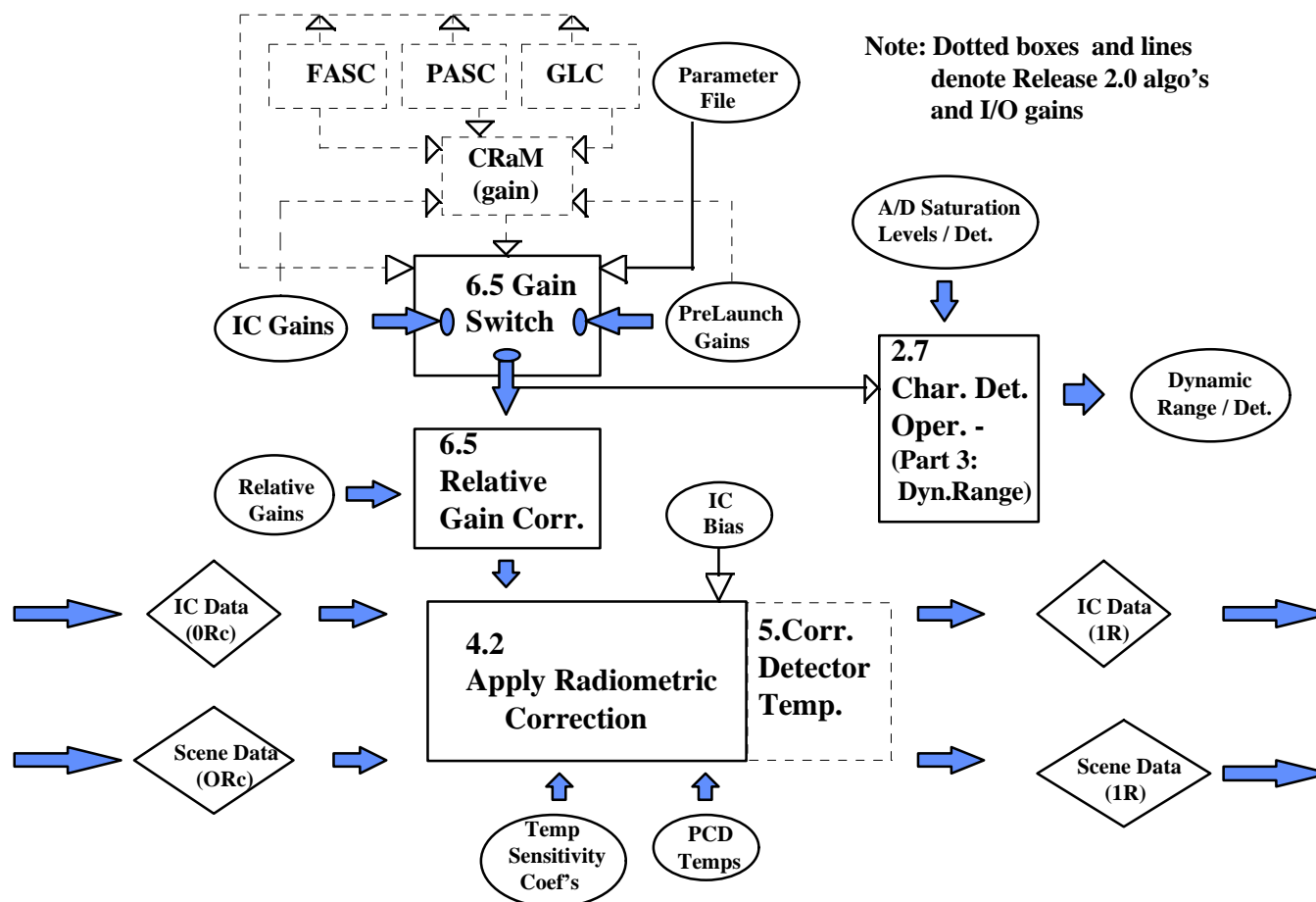
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Step 3a - Process IC Data



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Step 4 - 1R Correction



Level 1R Processing (Day Scene)

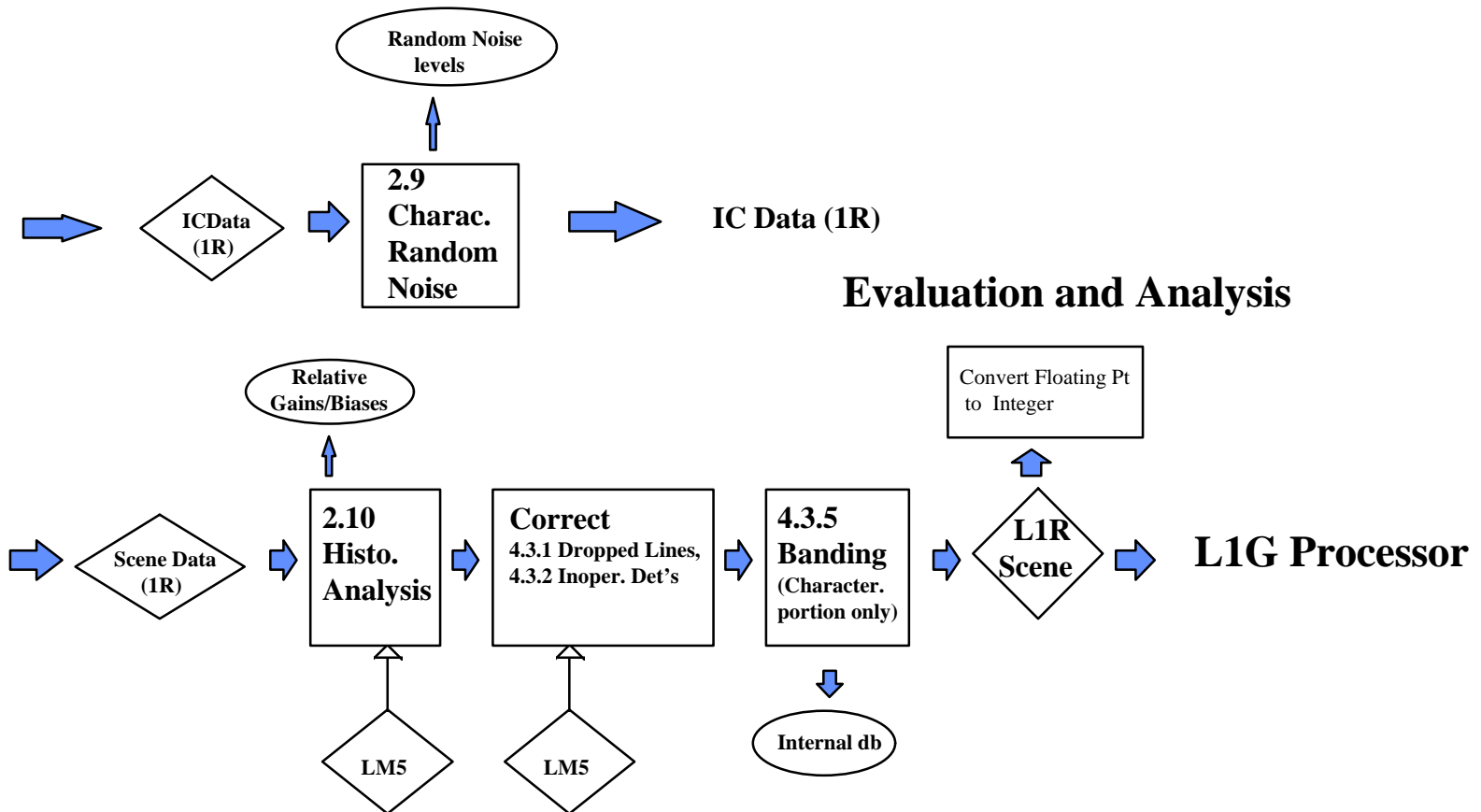
Release 1.0

Step 4. 1R Correction

(revised 9/11)

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Step 5 - 1R Characterization and Calibration



Level 1R Processing (Day Scene)

Release 1.0

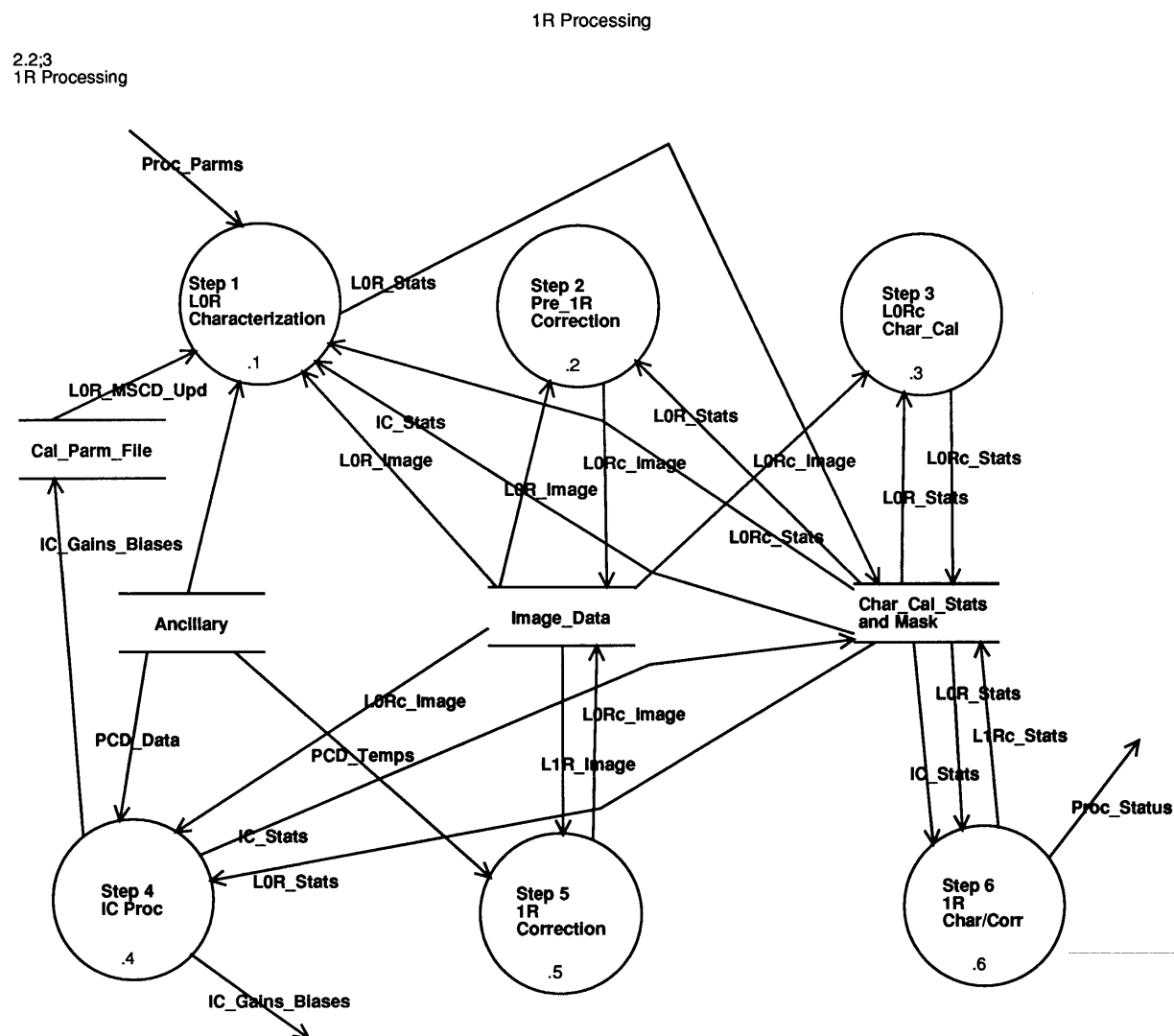
Step 5.0 1R Radiometric Characterization/Correction

(Scenario 1: No Correction for Striping and Banding Effects)

(revised 11/25/96)

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Level 1R Processing Data Flow Diagram



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	RPS Software Reuse	

- Radiometry prototypes will be reused where they exist (about half of the algorithms)
- LAS utilities for characterizing and correcting banding and striping will likely be reused
- Oracle APIs will be used for writing characterization and calibration results into the database for long-term trending
- HDF APIs will be used for retrieving image and other HDF files and for writing out image files generated during Level 1R Processing

Geometry Subsystem

**Level 1G Processing
Geometric Characterization
Geometric Calibration**

- **Requirements changes since 2/96 PDR, Assumptions, Open Issues**
- **Geometry Context/External Interfaces**
- **Geometry Data Flow/Internal Interfaces**
- **Level 1G Processing**
- **Geometric Characterization**
- **Geometric Calibration**
- **LOC Estimates/Build Plan**

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	Requirements Changes Since February PDR	

- **Capability to process subintervals up to three WRS scenes in length added for compatibility with LPGS (CCR in work)**
- **Detector placement and delay calibration deleted based on algorithm accuracy performance**
- **One dimensional bulk resampling deleted**
 - **Importance reduced without detector placement calibration**
- **Geometry requirements allocation shown in System Design Specification**

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Design Assumptions

- **Image data flows are managed by MD**
 - Affects to/from but not data flow content
- **Image products include a DDR (or equivalent)**
 - Pending design of HDF 1G products
- **Characterization/calibration parameter databases are managed by E&A**
 - Affects to/from but not data flow content
- **Trending parameters are written to Oracle databases using IAS standard API calls**
 - Interface is defined by API calls, parameter names and types
- **Internal permanent data stores are created and maintained by test site setup software (engineering/test software)**
 - Design will not be documented to the standards of production s/w

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	Design Tool/Methodology	

- **Using Software Through Pictures (StP) CASE tool for Yourdon/DeMarco structured design**
 - **Symbology differs from CADRE**
 - **EDC will transition to CADRE after delivery of geometry subsystem to GSFC to support sustaining engineering**
- **StP used to create DFDs, structure charts, and data dictionary**
 - **DFDs in presentation package and SDS**
 - **Structure charts under development, samples available upon request**

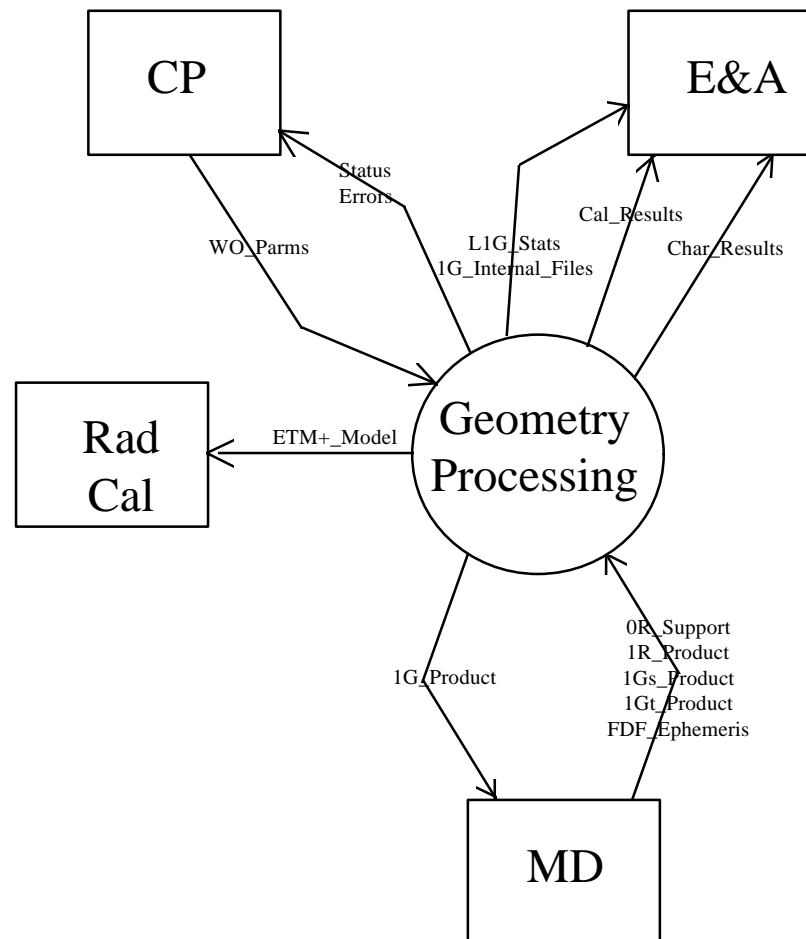
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Open Issues

Issue	Impact
2 GB HDF file size limit	Will require extra framing logic for 3-scene products
Work order/processing parameter passing mechanism	Assume software reads parameters from HDF file using IAS standard API
User interface concept	Interactive geometry software will use IDL for analyst GUI
Allocation of 0.7% radiometric accuracy requirement (3.2.3.3) to 1R and 1G	Assume internal use of floating point pixel values and unity gain resampling kernels is sufficient
Use of new SGI server hardware (O2000 architecture)	Verify that Oracle and IDL will run under IRIX 6.3 (O2 workstations) and IRIX 6.4 (O2000 servers)

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Geometry Context



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Context Diagram Data Dictionary

- **OR_Support = Metadata + PCD + MSCD + CPF**
- **1G_Internal_Files = Geometric_Grid + ETM+_Model + DDR**
- **1G_Product = [1Gs + DDR | 1Gp + DDR | 1Gt + DDR]**
- **1R_Product = 1R + DDR**
- **L1G_Stats = Attitude_Stats + Scan_Gap_Stats + Metadata_Report**
- **Char_Results = Geodetic_Stats + Geodetic_Accuracy_Report + Polynomial_Coefficients + Geometric_Accuracy_Report + I2I_Stats + Image_Registration_Report + B2B_Stats + B2B_Residuals + Band_Registration_Report**
- **Cal_Results = Alignment_Matrix + State_File + Orbit_Seq + Attitude_Seq + Innovation_Seq + Alignment_Cal_Report + Mirror_Scan_Stats + Mirror_Profile_Coefs + Mirror_Calibration_Report + Band_Center_Locations + B2B_Calibration_Report**

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External Interfaces

Data Flow	Data Store Type	From	To	Interface Type	Comments
Work Order Parm	Oracle DB / HDF File	CP	1G, Geo Char, Geo Cal	HDF File	HDF file generated from DB
Alignment Matrix	Oracle DB	Geo Cal	E&A	C API	CPF Field
Attitude Sequence	Oracle DB	Geo Cal	E&A	C API	Trending Info
Attitude Statistics	Oracle DB	1G	E&A	C API	Trending Info
B2B Statistics	Oracle DB	Geo Char	E&A	C API	Trending Info
Band Center Locations	Oracle DB	Geo Cal	E&A	C API	CPF Field
Errors	Oracle DB	1G, Geo Char, Geo Cal	CP	C API	Error Message
Geodetic Statistics	Oracle DB	Geo Char	E&A	C API	Trending Info
I2I Statistics	Oracle DB	Geo Char	E&A	C API	Trending Info
Innovation Sequence	Oracle DB	Geo Cal	E&A	C API	Trending Info
Mirror Profile Coefficients	Oracle DB	Geo Cal	E&A	C API	CPF Field
Mirror Scan Statistics	Oracle DB	Geo Cal	E&A	C API	Trending Info
Orbit Sequence	Oracle DB	Geo Cal	E&A	C API	Trending Info
Polynomial Coefficients	Oracle DB	Geo Char	E&A	C API	Trending Info
Scan Gap Statistics	Oracle DB	1G	E&A	C API	Trending Info
Status	Oracle DB	1G, Geo Char, Geo Cal	CP	C API	Processing Status
1Gp Image	HDF File	1G	MD	HDF File	Image File
1Gs Image	HDF File	1G	MD	HDF File	Assume 1G images are managed by MD
1Gs Image	HDF File	MD	Geo Char	HDF File	Image File
1Gt Image	HDF File	1G	MD	HDF File	Image File
1Gt Image	HDF File	MD	Geo Char, Geo Cal	HDF File	Image File
1R Image	HDF File	MD	1G	HDF File	Image File
CPF	HDF File	MD	1G, Geo Cal	HDF File	OR Product DFCB
DDR	HDF File	1G	MD, E&A	HDF File	To E&A for Viewing
DDR	HDF File	MD	1G, Geo Char, Geo Cal	HDF File	DDRs accompany all image files
Geometric Grid	HDF File	1G	E&A	HDF File	To E&A for Viewing

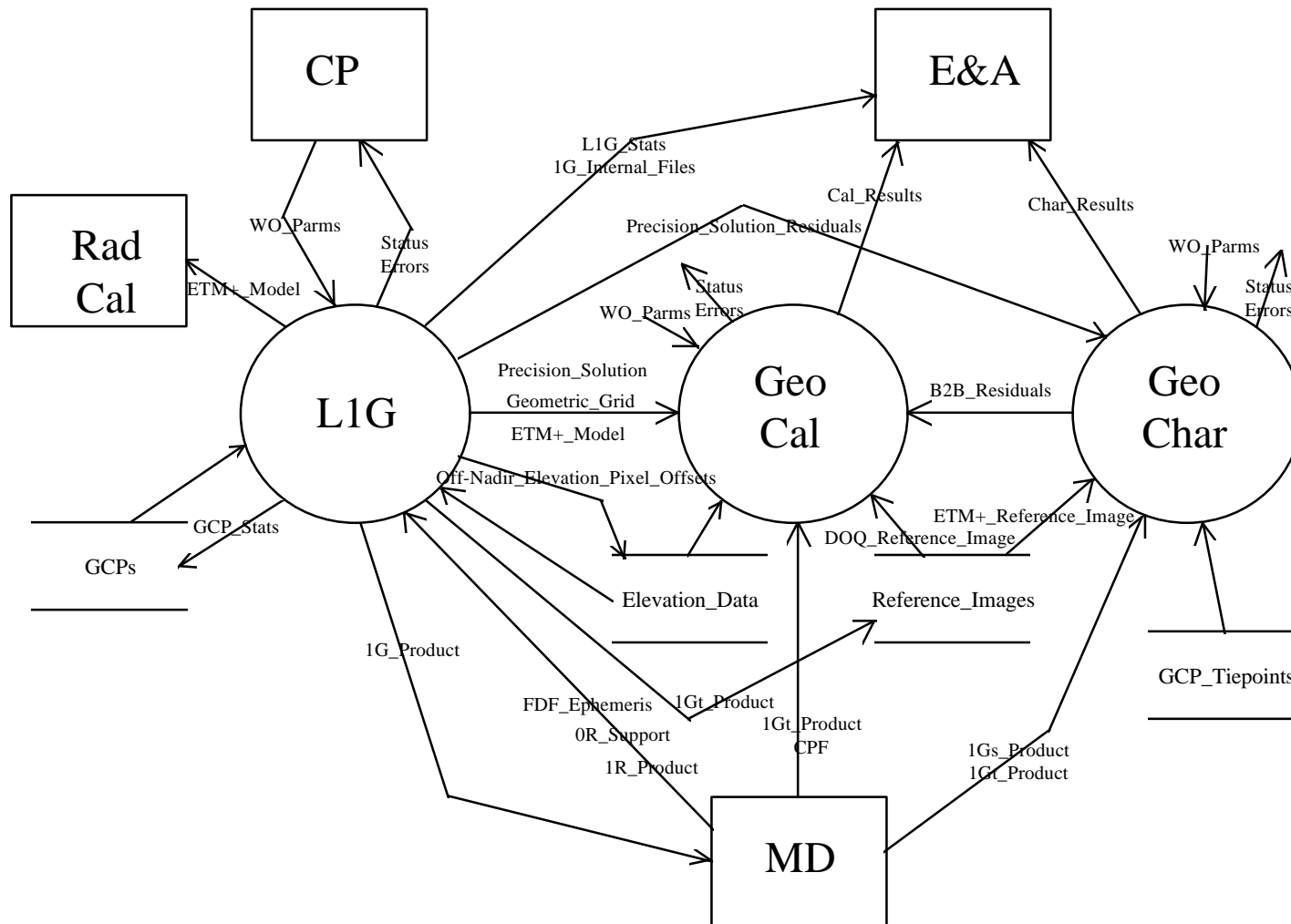
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External Interfaces (continued)

Data Flow	Data Store Type	From	To	Interface Type	Comments
Metadata	HDF File	MD	1G	HDF File	0R Product DFCB
MSCD	HDF File	MD	1G	HDF File	0R Product DFCB
PCD	HDF File	MD	1G	HDF File	0R Product DFCB
Alignment Calibration Report	ASCII File	Geo Cal	E&A	ASCII File	Text file containing formatted presentation of state file, orbit sequence., attitude sequence, innovation sequence and alignment matrix (if generated).
B2B Calibration Report	ASCII File	Geo Cal	E&A	ASCII File	Text file containing Band Center Locations and B2B residuals (post-B2B calibration).
B2B Residuals	ASCII File	Geo Char	E&A	ASCII File	To E&A for Viewing
Band Registration Report	ASCII File	Geo Char	E&A	ASCII File	Text file containing B2B Stats and B2B residuals.
ETM+ Model	ASCII File	1G	E&A	ASCII File	To E&A for Viewing
ETM+ Model	ASCII File	1G	Rad Cal	C API	Calls to map input pixel/line to ground
FDF Ephemeris	ASCII File	MD	1G	ASCII File	MOC/IAS ICD
Geodetic Accuracy Report	ASCII File	Geo Char	E&A	ASCII File	Text file containing Geodetic Stats and Precision Correction Residuals
Geometric Accuracy Report	ASCII File	Geo Char	E&A	ASCII File	Text file containing Visual Stats, GCP Residuals, and Poly Residuals
Image Registration Report	ASCII File	Geo Char	E&A	ASCII File	Text file containing I2I Stats and I2I residuals.
Metadata Report	ASCII File	1G	E&A	ASCII File	To E&A for Viewing
Mirror Calibration Report	ASCII File	Geo Cal	E&A	ASCII File	Text file containing formatted presentation of Mirror Scan Stats and Mirror Profile Coefficients
State File	ASCII File	Geo Cal	E&A	ASCII File	To E&A for Viewing

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Geometry Internal Data Flow



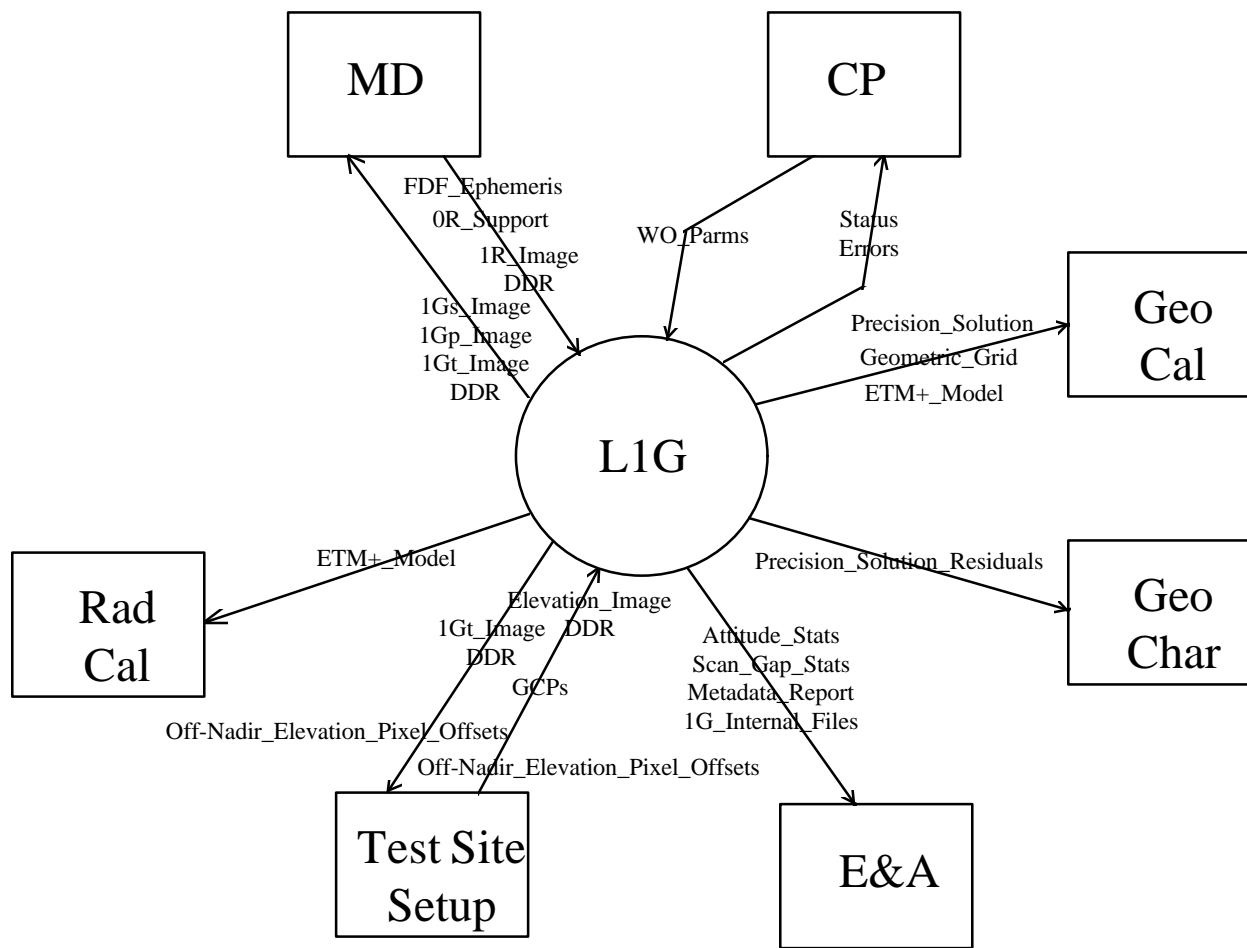
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Internal Interfaces

Data Flow	Data Store Type	From	To	Interface Type	Comments
DDR	HDF File	1G	Geo Char	HDF File	Accompanies 1Gt ETM+ Reference Image
DDR	HDF File	Geom Permanent Data	1G, Geo Cal	HDF File	Permanent supporting data set (created by test tools) accompanying Elevation Image and DOQ Reference Image
DOQ Reference Image	HDF File	Geom Permanent Data	Geo Cal	HDF File	Permanent supporting data set created by test tools
Elevation Image	HDF File	Geom Permanent Data	1G, Geo Cal	HDF File	Permanent supporting data set created by test tools
ETM+ Reference Image	HDF File	1G	Geo Char	HDF File	1Gt kept as permanent data set
GCP Imagery	HDF File	Geom Permanent Data	1G	HDF File	Permanent supporting data set created by test tools
GCP Statistics	HDF File	1G	Geom Permanent Data	HDF File	Updates fields in permanent HDF GCP tiepoint file
GCP Tiepoints	HDF File	Geom Permanent Data	1G, Geo Char	HDF File	Permanent supporting data set created by test tools
Geometric Grid	HDF File	1G	Geo Cal	HDF File	For Scan Mirror & B2B
B2B Residuals	ASCII File	Geo Char	Geo Cal	ASCII File	Pixel, line coordinates and deltas for all test points and all band pairs
ETM+ Model	ASCII File	1G	Geo Cal	ASCII File	For Scan Mirror Cal
Off Nadir Elev Pixel Offsets	ASCII File	1G	Geo Cal	ASCII File	Resampler output
Precision Solution	ASCII File	1G	Geo Cal	ASCII File	For Alignment Cal
Precision Solution Residuals	ASCII File	1G	Geo Char	ASCII File	GCP locations, pre- and post-fit residuals, and outlier flags

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Level 1G Processing Context

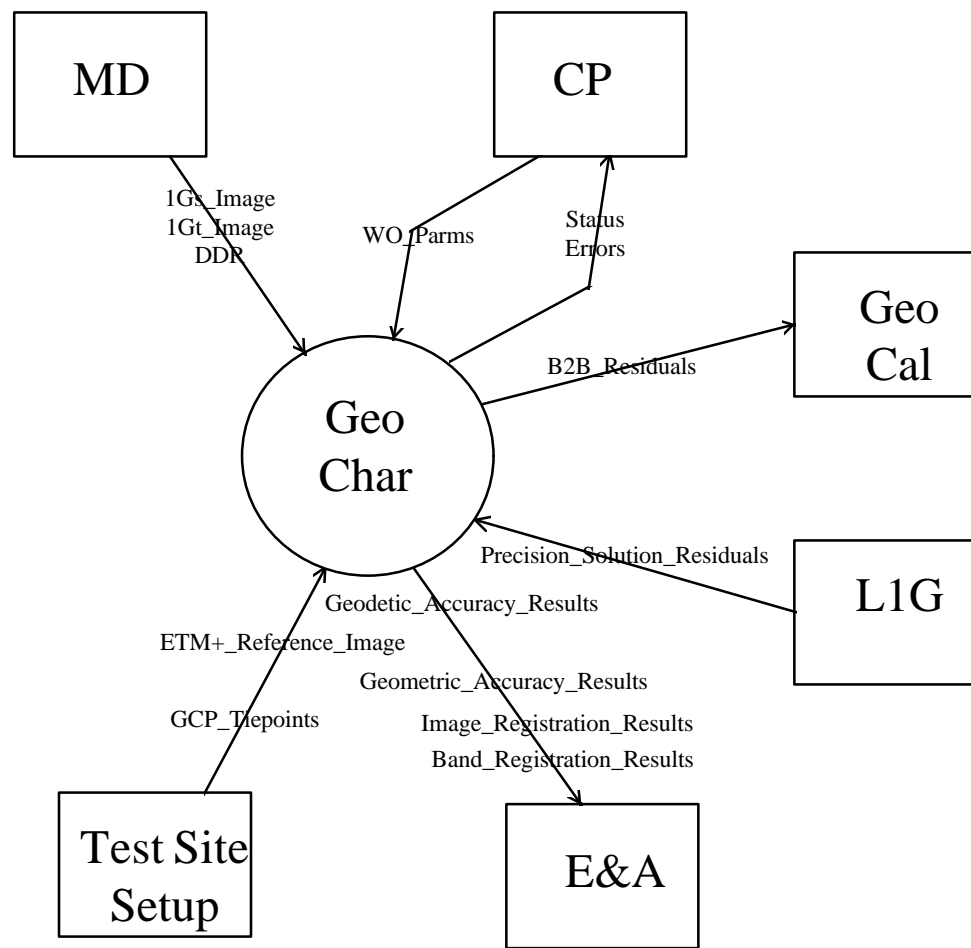


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	Level 1G Data Flow	

- **TMINIT**
 - Create and initialize the ETM+ satellite model using PCD, MSCD, and CPF
- **TMGRID**
 - Generate an ETM+ reprojection grid to map input image space to output image space
- **TMRESAMPLE**
 - Resample pixel values from input space to output space optionally applying terrain correction
 - Options for cubic convolution, nearest neighbor, or MTF compensation interpolation
- **PRECISION**
 - Update satellite model using ground control points

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Geo Characterization Context



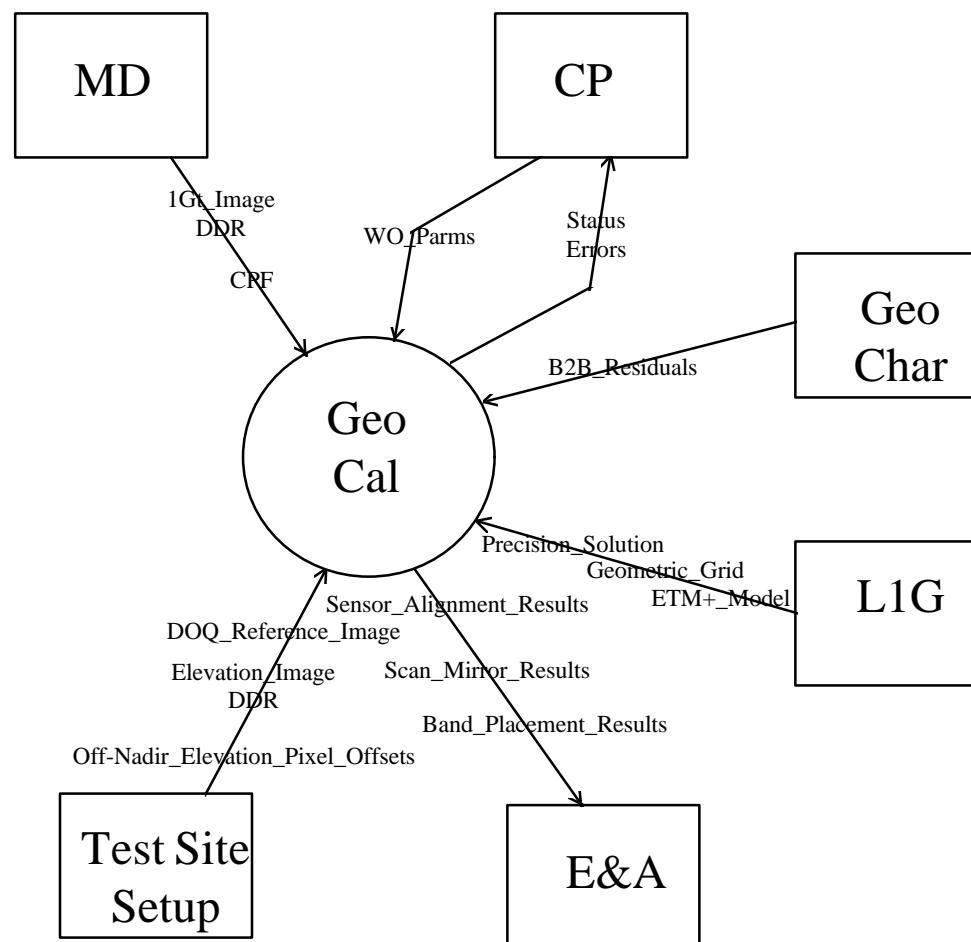
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	Geo Characterization Data Flow	

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	Geo Characterization CSC Functions	

- **GEODETIC**
 - Verify absolute geodetic accuracy of 1Gs products using ground control points
- **GEOMETRIC**
 - Visual check on image geometric quality (geometric artifacts)
 - Detect residual geometric distortion by plotting GCP residuals
 - Quantify residual distortion by fitting polynomial to residuals
- **IMAGE TO IMAGE**
 - Measure multi-temporal registration accuracy between two ETM+ images
- **BAND TO BAND**
 - Measure band to band registration accuracy in 1Gs products

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Geo Calibration Context



	IAS Delta System/Preliminary Design Review	
	Geo Calibration Data Flow	

- **SENSOR ALIGNMENT**
 - Use precision correction results to estimate ETM+ instrument to Landsat 7 navigation base alignment
- **SCAN MIRROR**
 - Use high precision reference image to estimate updates to ETM+ scan mirror profile
- **BAND PLACEMENT**
 - Use band to band registration measurements to estimate focal plane locations of the eight ETM+ band centers

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Line of Code Estimates

CSCI/CSC	Algorithms	Total LOC	New LOC	Reuse LOC	Language	Reuse Source
L1G						
TMINIT	Create Model	3000	500	2500	C	1G Prototype Model Creation Libraries
TMGRID	Generate Correction Grid	1500	500	1000	C	1G TMRECTIFY Prototype
	Call Model (libraries)	4500	1000	3500	C	1G Prototype LOS Projection Libraries
TMRESAMPLE	Resampling, Terrain Corr	14000	7000	7000	C	Resampling and Terrain Prototypes
PRECISION	Precision Correction	3000	600	2400	C	Precision Correction Prototype
	Correlation (libraries)	2000	400	1600	C	LAS Correlate Software
L1G Totals		26000	9600	16400		
Geo Cal						
ALIGNMENT	Sensor Alignment Cal	1200	300	900	C w/ IDL UI	Sensor Alignment Prototype
MIRROR	Scan Mirror Calibration	2200	600	1600	C w/ IDL UI	LAS Correlate Software
BAND	Band Placement Cal	600	200	400	C w/ IDL UI	Band to Band Prototype and LAS Correlate
Geo Cal Totals		4000	1100	2900		
Geo Char						
GEOMETRIC	Geometric Acc Assess	750	600	150	IDL/C	Polynomial Fit Prototype
GEODETIC	Geodetic Acc Assess	500	300	200	IDL/C	Geodetic Assessment Prototype
IMAGE TO IMAG	Image to Image Reg	2000	400	1600	C w/ IDL UI	LAS Correlate Software
BAND TO BAND	Band to Band Reg	1800	200	1600	C w/ IDL UI	LAS Correlate Software
Geo Char Totals		5050	1500	3550		
Totals		35050	12200	22850		

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Geometry Build Plan

- **Release 1**
 - **B1 - Release 1.0 - TMINIT, TMGRID**
 - **Test with prototype resampler**
 - **B2 - Release 1.1 - B1 + TMRESAMPLE**
 - **B3 - Release 1.2 - B2 + PRECISION**
- **Release 2**
 - **B4 - Release 2.1 - Geometric Characterization**
 - **B5 - Release 2.2 - B4 + Geometric Calibration**
 - **B6 - Release 1.3 - B3 + Interval Processing**
 - **Updates to TMINIT, TMGRID, TMRESAMPLE**

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End-to-End Scenario (1 of 5)

Step	Agent	Action
1	Operator	Obtain list of data requests for open work orders
2	Operator	Review DAAC holding that satisfy data requests
3	Operator	Browse data for applicability at IAS
4	Operator	Order data for processing at IAS
5	Operator	Obtain time span of data request for FDF data
6	Operator	Generate data request for concentrated ephem
7	DMS	Send data request to MOC
8	Operator	Update work order for scene_id & product_id (Create 1G uses PCD; create 1G uses FDF)
9	Operator	Override default parameters for work order

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End-to-End Scenario (2 of 5)

Step	Agent	Action
10	MOC	Send concentrated ephem (received from FDF)
11	DMS	Detect arrival of ephem data from MOC
12	DMS	Convert ephem data to local format
13	DMS	Catalog converted ephem data
14	DAAC	Send notification of data availability (DAN)
15	DMS	Retrieve files from DAAC as specified in DAN associated with a scene_id
16	DMS	Verify consistency/quality of retrieved files per scene_id
17	DMS	Correct PCD
18	DMS	Correct MSCD
19	DMS	Generate DDR

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End-to-End Scenario (3 of 5)

Step	Agent	Action
20	DMS	Locate work order for verified scene_id
21	DMS	Update work order with filename
22	PCS	Identify work order ready for processing
23	PCS	Verify sufficient system resources for work order
24	PCS	Submit work order for processing
25	GPS	Initialize ETM+ model
26	RPS	Process 0R to 1R (Level 1R Processing)
27	GPS	Generate 1Gs image
28	GPS	Perform GCP correlation
29	PCS	Indicate work order pending analyst's action

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End-to-End Scenario (4 of 5)

Step	Agent	Action
30	Analyst	Obtain list of work orders pending interactive analysis
31	Analyst	Iterate on precision solution
32	Analyst	Notify resumption of work order
33	PCS	Identify work order ready for resumption
34	GPS	Update ETM+ model
35	GPS	Generate 1Gt image
36	PCS	Indicate work order pending evaluation & assessment
37	Analyst	Obtain list of completed work orders
38	Analyst	Perform scan mirror calibration

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End-to-End Scenario (5 of 5)

Step	Agent	Action
39	Analyst	Assess the results of work order
40	Analyst	Generate geometric accuracy report
41	Analyst	Notify analysis status for completed of work order
42	DMS	Delete files associated with analyzed work order